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Specification

METHOD AND DEVICE FOR CARBURIZING AT SUBATMOSPHERIC PRESSURES

The invention relates to a method of carburizing at subatmospheric pressures, in the case of which a treatment gas containing hydrocarbons is supplied to a treatment chamber and an exhaust stream exits from the treatment chamber.

In addition, the invention relates to a device for carburizing at subatmospheric pressures, having at least one treatment chamber, at least one feeding line, by way of which a treatment gas containing hydrocarbons is supplied to the treatment chamber, and at least one evacuating line by way of which the exhaust stream is withdrawn from the treatment chamber by means of an evacuating device.

A method of the above-mentioned type for carburizing at subatmospheric pressures is known, for example, from the technical article "Influencing the Carbon Transfer When Carburizing at Subatmospheric Pressures", Technical Journal HTM 54 (1999).

In the case of the methods and devices for carburizing at subatmospheric pressures which are part of the prior art - here, pressures of up to 20 mbar are preferably used -, the problem arises that a sooting of the system - thus of the treatment chamber as well as of the evacuating pump - takes place when the soot limit is exceeded. Furthermore, an undesirable tar formation takes place in the interior of the treatment chamber.

The cause of the above is the fact that, when a defined quantity and composition of hydrocarbon-containing or of a hydrocarbon-containing treatment gas is supplied into the treatment chamber, an uncontrolled decomposition of excess hydrocarbons can take place. Furthermore, the calculated hydrocarbon definition may be too low which results in faulty calculations in the carbon transition computation and the carbon behavior computation.

With respect to the methods which are part of the prior art, it is also a disadvantage that, when the transferred carbon is calculated, the theoretical composition of the used hydrocarbon-containing treatment gas is always used as the basis. This means, for example, that, when propane is used as the hydrocarbon-containing treatment gas, the composition C_3H_8 is used as the basis. However, when technical propane is used, only

the heating value but not the exact composition is guarantied. The sum of the carbon in the technical propane is therefore not identical with the theoretical C content of pure propane which is taken into account when calculating the transferred amount of carbon. This also leads to inaccuracies in the computing result.

It is an object of the present invention to indicate a method of the above-mentioned type as well as a device of the above-mentioned type for carburizing at subatmospheric pressure, which avoid the above-mentioned disadvantages.

With respect to the method, this object is achieved in that the opacity of the gas atmosphere existing in the treatment chamber and/or the opacity of the exhaust stream exiting from the treatment chamber is/are determined and, as a function of the determined opacity, the feeding of the hydrocarbon-containing treatment gas into the treatment chamber is regulated.

With respect to the device, the object is achieved in that at least one valve is arranged in the feeding line; at least one device for determining the opacity of the gaseous atmosphere prevailing in the treatment chamber is arranged in the treatment chamber; and/or at least one opacity probe is arranged in the evacuating line; and an analyzing unit is provided which, as a function of the opacity of the exhaust stream determined by means

of the device for determining the opacity of the gaseous atmosphere prevailing in the treatment chamber, and/or by means of the opacity probe, regulates the feeding of the hydrocarbon-containing treatment gas into the treatment chamber by means of driving the valve.

The method according to the invention, the device according to the invention as well as additional further developments thereof will be discussed in the following by means of the embodiment illustrated in the figure.

The figure shows an only schematically illustrated treatment chamber 3 to which the hydrocarbon-containing treatment gas is fed by way of a feeding line 1. The following gases are preferably used as hydrocarbon-containing treatment gases: Alkanes, alkenes, alkines, derivatives of the aforementioned, optionally in combination with hydrogen.

By way of the evacuating line 4, in which a vacuum pump 6 is arranged, the desired subatmospheric pressure is set in the treatment chamber 3. As mentioned above, the work preferably takes place at pressures of up to 20 mbar, preferably at pressures between 3 and 20 mbar.

According to the invention, a valve, particularly a control

valve 2, is now arranged in the feeding line 1. According to the invention, the evacuating line 4 has an opacity probe 5. The control valve 2 as well as the opacity probe 5 are connected by way of data lines 7 or 8 with an analyzing unit 9. Corresponding to an advantageous further development of the device according to the invention, the analyzing unit (9) permits the setting of an opacity limit value.

According to the invention, the opacity of the exhaust stream exiting from the treatment chamber 3 by way of the evacuating line 4 is now determined or measured and, as a function of the determined opacity, the feeding of the hydrocarbon-containing treatment gas by way of the feeding line 1 into the treatment chamber 3 is regulated.

If an opacity value, which was set or can be set, of the exhaust stream withdrawn from the treatment chamber 3 by way of the evacuating line 4 is exceeded, the feeding of the hydrocarbon-containing treatment gas by way of the feeding line 1 into the treatment chamber 3 can be either completely interrupted, or the quantity of the hydrocarbon-containing treatment gas fed to the treatment chamber 3 can at least be reduced. When there again is a falling below the opacity value, which was set or can be set, the feeding of the hydrocarbon-containing treatment gas into the treatment chamber 3 can be

resumed, or the amount of the fed hydrocarbon-containing treatment gas can be increased again. The invention thereby permits a continuous regulating of the hydrocarbon-containing treatment gas fed to the treatment chamber 3.

As an alternative or in addition to the opacity probe 5 provided in the evacuating line 4, a device 10 for determining the opacity of the gaseous atmosphere prevailing in the treatment chamber 3 may be provided. By way of a data line 11, this device 10 for determining the opacity is also connected with the analyzing unit 9.

The above-mentioned device 10 for determining the opacity of the gaseous atmosphere prevailing in the treatment chamber 3 can also be constructed as a monitoring connection piece. The device 10 for determining the opacity of the gaseous atmosphere prevailing in the treatment chamber 3 permits a close-to-the-charge measuring of the gaseous atmosphere prevailing in the treatment chamber 3. Falsifying effects, which may occur, for example, during the cooling of the exhaust stream withdrawn from the treatment chamber 3 are avoided in this variant of the method. However, it is a disadvantage of this method of operation that the separation of aerosols, which occurs only when the exhaust stream is cooled, is not yet visible and therefore determinable in the treatment chamber 3 itself.

The method according to the invention as well as the device according to the invention therefore permit a controlled feeding of the hydrocarbon-containing treatment gas into the treatment chamber, whereby an uncontrolled decomposition of excessive hydrocarbons in the treatment chamber as well as in the evacuating line and thus a soot and tar formation can be effectively avoided. A large amount of the undesired deposits within the treatment chamber on the material to be treated in the treatment chamber or in the evacuating line is reliably avoided by means of the method according to the invention or by means of the device according to the invention.